Practitioner's Docket No. 454-010513-US(PAR)

CHAPTER II

Preliminary Classification:
Proposed Class:
Subclass:

NOTE: "All applicants are requested to include a preliminary classification on newly filed patent applications. The preliminary classification, preferably class and subclass designations, should be identified in the upper right-hand corner of the letter of transmittal accompanying the application papers, for example 'Proposed Class 2, subclass 129.'" M.P.E.P., § 601, 7th ed.

TRANSMITTAL LETTER TO THE UNITED STATES ELECTED OFFICE (EO/US) (ENTRY INTO U.S. NATIONAL PHASE UNDER CHAPTER II)

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/EP99/01170	23 February 1999	23 February 1999

TITLE OF INVENTION
SENSOR MODULE WITH INTEGRATED SIGNAL PROCESSING

APPLICANT(S)
Jorg Schieferdecker, Mischa SCHULZE

Box PCT
Assistant Commissioner for Patents
Washington D.C. 20231
ATTENTION: EO/US

CERTIFICATION UNDER 37 C.F.R. §§ 1.8(a) and 1.10*
(When using Express Mail, the Express Mail label number is mandatory; Express Mail certification is optional.)

I hereby certify that, on the date shown below, this correspondence is being:

MAILING

☒ deposited with the United States Postal Service in an envelope addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231

37 C.F.R. § 1.8(a)

☐ with sufficient postage as first class mail.

37 C.F.R. § 1.10 *

☒ as "Express Mail Post Office to Addressee"
Mailing Label No. EL627509059US (mandatory)

TRANSMISSION

☐ facsimile transmitted to the Patent and Trademark Office, (703) _____-_____.

June Adams
Signature

Date: 8/22/01

June Adams
(type or print name of person certifying)

** Only the date of filing (§ 1.6) will be the date used in a patent term adjustment calculation, although the date on any certificate of mailing or transmission under § 1.8 continues to be taken into account in determining timeliness. See § 1.703(f). Consider "Express Mail Post Office to Addressee" (§ 1.10) or facsimile transmission (§ 1.6(d)) for the reply to be accorded the earliest possible filing date for patent term adjustment calculations.*

NOTE: To avoid abandonment of the application, the applicant shall furnish to the USPTO, not later than 20 months from the priority date: (1) a copy of the international application, unless it has been previously communicated by the International Bureau or unless it was originally filed in the USPTO; and (2) the basic national fee (see 37 C.F.R. § 1.492(a)). The 30-month time limit may not be extended. 37 C.F.R. § 1.495.

***WARNING:** Where the items are those which can be submitted to complete the entry of the international application into the national phase are subsequent to 30 months from the priority date the application is still considered to be in the international state and if mailing procedures are utilized to obtain a date the express mail procedure of 37 C.F.R. § 1.10 must be used (since international application papers are not covered by an ordinary certificate of mailing—See 37 C.F.R. § 1.8.*

NOTE: Documents and fees must be clearly identified as a submission to enter the national state under 35 U.S.C. § 371 otherwise the submission will be considered as being made under 35 U.S.C. § 111. 37 C.F.R. § 1.494(f).

I. Applicant herewith submits to the United States Elected Office (EO/US) the following items under 35 U.S.C. § 371:

a. ☒ This express request to immediately begin national examination procedures (35 U.S.C. § 371(f)).

b. ☒ The U.S. National Fee (35 U.S.C. § 371(c)(1)) and other fees (37 C.F.R. § 1.492) as indicated below:

2. Fees

CLAIMS FEE	(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS
☐*	TOTAL CLAIMS 17	17 −20=	0	× $18.00=	$ 0
	INDEPENDENT CLAIMS 1	1 −3=	0	× $80.00=	0
	MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ $270.00	
BASIC FEE**	☐ U.S. PTO WAS INTERNATIONAL PRELIMINARY EXAMINATION AUTHORITY Where an international preliminary examination fee as set forth in § 1.482 has been paid on the international application to the U.S. PTO: ☐ and the international preliminary examination report states that the criteria of novelty, inventive step (non-obviousness) and industrial activity, as defined in PCT Article 33(1) to (4) have been satisfied for all the claims presented in the application entering the national stage (37 C.F.R. § 1.492(a)(4)) ..... $100.00 ☐ and the above requirements are not met (37 C.F.R. § 1.492(a)(1)) ..... $690.00 XX U.S. PTO WAS NOT INTERNATIONAL PRELIMINARY EXAMINATION AUTHORITY Where no international preliminary examination fee as set forth in § 1.482 has been paid to the U.S. PTO, and payment of an international search fee as set forth in § 1.445(a)(2) to the U.S. PTO: ☐ has been paid (37 C.F.R. § 1.492(a)(2)) ..... $710.00 ☐ has not been paid (37 C.F.R. § 1.492(a)(3)) ..... $1000.00 ☒ where a search report on the international application has been prepared by the European Patent Office or the Japanese Patent Office (37 C.F.R. § 1.492(a)(5)) $860.00				860.00
	Total of above Calculations				= 860.00
SMALL ENTITY	Reduction by 1/2 for filing by small entity, if applicable. Assertion must be made. (note 37 C.F.R. § 1.27)				−
	Subtotal				860.00
	Total National Fee				$ 860.00
	Fee for recording the enclosed assignment document $40.00 (37 C.F.R. § 1.21(h)). (See Item 13 below). See attached "ASSIGNMENT COVER SHEET".				
TOTAL	Total Fees enclosed				$ 860.00

*See attached Preliminary Amendment Reducing the Number of Claims.

☒ Attached is a ☒ check ☐ money order in the amount of $ 860.00

☐ Authorization is hereby made to charge the amount of $ _____

☒ to Deposit Account No. 16-1350

☐ to Credit card as shown on the attached credit card information authorization form PTO-2038.

WARNING: *Credit card information should* ***not*** *be included on this form as it may become public.*

☒ Charge any additional fees required by this paper or credit any overpayment in the manner authorized above.

A duplicate of this paper is attached.

"WARNING: *"To avoid abandonment of the application the applicant shall furnish to the United States Patent and Trademark Office not later than the expiration of 30 months from the priority date: * * * (2) the basic national fee (see § 1.492(a)). The 30-month time limit may not be extended." 37 C.F.R. § 1.495(b).*

WARNING: *If the translation of the international application and/or the oath or declaration have not been submitted by the applicant within thirty (30) months from the priority date, such requirements may be met within a time period set by the Office. 37 C.F.R. § 1.495(b)(2). The payment of the surcharge set forth in § 1.492(e) is required as a condition for accepting the oath or declaration later than thirty (30) months after the priority date. The payment of the processing fee set forth in § 1.492(f) is required for acceptance of an English translation later than thirty (30) months after the priority date. Failure to comply with these requirements will result in abandonment of the application. The provisions of § 1.136 apply to the period which is set. Notice of Jan. 3, 1993, 1147 O.G. 29 to 40.*

☐ **Assertion of Small Entity Status**

☐ **Applicant hereby asserts status as a small entity under 37 C.F.R. § 1.27.**

NOTE: 37 C.F.R. § 1.27(c) deals with the assertion of small entity status, whether by a written specific declaration thereof or by payment as a small entity of the basic filing fee or the fee for the entry into the national phase as states:

"(c) Assertion of small entity status. Any party (person, small business concern or nonprofit organization) should make a determination, pursuant to paragraph (f) of this section, of entitlement to be accorded small entity status based on the definitions set forth in paragraph (a) of this section, and must, in order to establish small entity status for the purpose of paying small entity fees, actually make an assertion of entitlement to small entity status, in the manner set forth in paragraphs (c)(1) or (c)(3) of this section, in the application or patent in which such small entity fees are to be paid.

(1) Assertion by writing. Small entity status may be established by a written assertion of entitlement to small entity status. A written assertion must:

(i) Be clearly identifiable;

(ii) Be signed (see paragraph (c)(2) of this section); and

(iii) Convey the concept of entitlement to small entity status, such as by stating that applicant is a small entity, or that small entity status is entitled to be asserted for the application or patent. While no specific words or wording are required to assert small entity status, the intent to assert small entity status must be clearly indicated in order to comply with the assertion requirement.

(2) Parties who can sign and file the written assertion. The written assertion can be signed by:

(i) One of the parties identified in §§ 1.33(b) (e.g., an attorney or agent registered with the Office), §§ 3.73(b) of this chapter notwithstanding, who can also file the written assertion;

(ii) At least one of the individuals identified as an inventor (even though a §§ 1.63 executed oath or declaration has not been submitted), notwithstanding §§ 1.33(b)(4), who can also file the written assertion pursuant to the exception under §§ 1.33(b) of this part; or

(iii) An assignee of an undivided part interest, notwithstanding §§ 1.33(b)(3) and 3.73(b) of this chapter, but the partial assignee cannot file the assertion without resort to a party identified under §§ 1.33(b) of this part.

(3) Assertion by payment of the small entity basic filing or basic national fee. The payment, by any party, of the exact amount of one of the small entity basic filing fees set forth in §§ 1.16(a), (f), (g), (h), or (k), or one of the small entity basic national fees set forth in §§ 1.492(a)(1), (a)(2), (a)(3), (a)(4), or (a)(5), will be treated as a written assertion of entitlement to small entity status even if the type of basic filing or basic national fee is inadvertently selected in error.

(i) If the Office accords small entity status based on payment of a small entity basic filing or basic national fee under paragraph (c)(3) of this section that is not applicable to that application, any balance of the small entity fee that is applicable to that application will be due along with the appropriate surcharge set forth in §§ 1.16(e), or §§ 1.16(l).

(ii) The payment of any small entity fee other than those set forth in paragraph (c)(3) of this section (whether in the exact fee amount or not) will not be treated as a written assertion of entitlement to small entity status and will not be sufficient to establish small entity status in an application or a patent."

3. ☒ A copy of the International application as filed (35 U.S.C. § 371(c)(2)):

NOTE: Section 1.495 (b) was amended to require that the basic national fee and a copy of the international application must be filed with the Office by 30 months from the priority date to avoid abandonment. "The International Bureau normally provides the copy of the international application to the Office in accordance with PCT Article 20. At the same time, the International Bureau notifies applicant of the communication to the Office. In accordance with PCT Rule 47.1, that notice shall be accepted by all designated offices as conclusive evidence that the communication has duly taken place. Thus, if the applicant desires to enter the national stage, the applicant normally need only check to be sure the notice from the International Bureau has been received and then pay the basic national fee by 30 months from the priority date." Notice of Jan. 7, 1993, 1147 O.G. 29 to 40, at 35-36. See item 14c below.

a. ☒ is transmitted herewith.

b. ☐ is not required, as the application was filed with the United States Receiving Office.

c. ☒ has been transmitted

i. ☒ by the International Bureau.

Date of mailing of the application (from form PCT/1B/308):

8/31/00

ii. ☐ by applicant on _____. *(Date)*

4. ☒ A translation of the International application into the English language (35 U.S.C. § 371(c)(2)):

a. ☒ is transmitted herewith.

b. ☐ is not required as the application was filed in English.

c. ☐ was previously transmitted by applicant on _____. *(Date)*

d. ☐ will follow.

5. ☒ Amendments to the claims of the International application under PCT Article 19 (35 U.S.C. § 371(c)(3)):

NOTE: The Notice of January 7, 1993 points out that 37 C.F.R. § 1.495(a) was amended to clarify the existing and continuing practice that PCT Article 19 amendments must be submitted by 30 months from the priority date and this deadline may not be extended. The Notice further advises that: "The failure to do so will not result in loss of the subject matter of the PCT Article 19 amendments. Applicant may submit that subject matter in a preliminary amendment filed under section 1.121. In many cases, filing an amendment under section 1.121 is preferable since grammatical or idiomatic errors may be corrected." 1147 O.G. 29-40, at 36.

a. ☐ are transmitted herewith.

b. ☐ have been transmitted

i. ☐ by the International Bureau.

Date of mailing of the amendment (from form PCT/1B/308):

_____.

ii. ☐ by applicant on _____. *(Date)*

c. ☒ have not been transmitted as

i. ☒ applicant chose not to make amendments under PCT Article 19. Date of mailing of Search Report (from form PCT/ISA/210.):

10/1/99.

ii. ☐ the time limit for the submission of amendments has not yet expired. The amendments or a statement that amendments have not been made will be transmitted before the expiration of the time limit under PCT Rule 46.1.

6. ☒ A translation of the amendments to the claims under PCT Article 19 (38 U.S.C. § 371(c)(3)):

a. ☐ is transmitted herewith.

b. ☐ is not required as the amendments were made in the English language.

c. ☒ has not been transmitted for reasons indicated at point 5(c) above.

7. ☒ A copy of the international examination report (PCT/IPEA/409)

☒ is transmitted herewith.

☐ is not required as the application was filed with the United States Receiving Office.

8. ☐ Annex(es) to the international preliminary examination report

a. ☐ is/are transmitted herewith.

b. ☐ is/are not required as the application was filed with the United States Receiving Office.

9. ☐ A translation of the annexes to the international preliminary examination report

a. ☐ is transmitted herewith.

b. ☐ is not required as the annexes are in the English language.

10. [X] An oath or declaration of the inventor (35 U.S.C. § 371(c)(4)) complying with 35 U.S.C. § 115

a. ☐ was previously submitted by applicant on _____. *(Date)*

b. ☐ is submitted herewith, and such oath or declaration

i. ☐ is attached to the application.

ii. ☐ identifies the application and any amendments under PCT Article 19 that were transmitted as stated in points 3(b) or 3(c) and 5(b); and states that they were reviewed by the inventor as required by 37 C.F.R. § 1.70.

c. [X] will follow.

II. Other document(s) or information included:

11. [X] An International Search Report (PCT/ISA/210) or Declaration under PCT Article 17(2)(a):

a. [X] is transmitted herewith.

b. [X] has been transmitted by the International Bureau.

Date of mailing (from form PCT/IB/308): 8/31/00.

c. ☐ is not required, as the application was searched by the United States International Searching Authority.

d. ☐ will be transmitted promptly upon request.

e. ☐ has been submitted by applicant on _____. *(Date)*

12. [X] An Information Disclosure Statement under 37 C.F.R. §§ 1.97 and 1.98:

a. [X] is transmitted herewith.

Also transmitted herewith is/are:

[X] Form PTO-1449 (PTO/SB/08A and 08B).

[X] Copies of citations listed.

b. ☐ will be transmitted within THREE MONTHS of the date of submission of requirements under 35 U.S.C. § 371(c).

c. ☐ was previously submitted by applicant on _____. *(Date)*

13. ☐ An assignment document is transmitted herewith for recording.

A separate ☐ "COVER SHEET FOR ASSIGNMENT (DOCUMENT) ACCOMPANYING NEW PATENT APPLICATION" or ☐ FORM PTO 1595 is also attached.

_____

_____

_____

14. ☒ Additional documents:
    a. ☒ Copy of request (PCT/RO/101)
    b. ☒ International Publication No. WO 00/50862
        i. ☐ Specification, claims and drawing
        ii. ☒ Front page only
    c. ☒ Preliminary amendment (37 C.F.R. § 1.121)
    d. ☒ Other
    PCT/IB/308, PCT/IB/306, PCT/IPEA/409,

15. ☒ The above checked items are being transmitted
    a. ☒ before 30 months from any claimed priority date.
    b. ☐ after 30 months.

16. ☐ Certain requirements under 35 U.S.C. § 371 were previously submitted by the applicant on _____, namely:

AUTHORIZATION TO CHARGE ADDITIONAL FEES

WARNING: *Accurately count claims, especially multiple dependant claims, to avoid unexpected high charges if extra claims are authorized.*

NOTE: "A written request may be submitted in an application that is an authorization to treat any concurrent or future reply, requiring a petition for an extension of time under this paragraph for its timely submission, as incorporating a petition for extension of time for the appropriate length of time. An authorization to charge all required fees, fees under § 1.17, or all required extension of time fees will be treated as a constructive petition for an extension of time in any concurrent or future reply requiring a petition for an extension of time under this paragraph for its timely submission. Submission of the fee set forth in § 1.17(a) will also be treated as a constructive petition for an extension of time in any concurrent reply requiring a petition for an extension of time under this paragraph for its timely submission." 37 C.F.R. § 1.136(a)(3).

NOTE: "Amounts of twenty-five dollars or less will not be returned unless specifically requested within a reasonable time, nor will the payer be notified of such amounts; amounts over twenty-five dollars may be returned by check or, if requested, by credit to a deposit account." 37 C.F.R. § 1.26(a).

☒ Please charge, in the manner authorized above, the following additional fees that may be required by this paper and during the entire pendency of this application:

☒ 37 C.F.R. § 1.492(a)(1), (2), (3), and (4) (filing fees)

WARNING: *Because failure to pay the national fee within 30 months without extension (37 C.F.R. § 1.495(b)(2)) results in abandonment of the application, it would be best to always check the above box.*

☒ 37 C.F.R. § 1.492(b), (c) and (d) (presentation of extra claims)

NOTE: Because additional fees for excess or multiple dependent claims not paid on filing or on later presentation must only be paid or these claims cancelled by amendment prior to the expiration of the time period set for response by the PTO in any notice of fee deficiency (37 C.F.R. § 1.492(d)), it might be best not to authorize the PTO to charge additional claim fees, except possible when dealing with amendments after final action.

☒ 37 C.F.R. § 1.17 (application processing fees)

☒ 37 C.F.R. § 1.17(a)(1)–(5) (extension fees pursuant to § 1.136(a).

☐ 37 C.F.R. § 1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 C.F.R. § 1.311(b))

NOTE: Where an authorization to charge the issue fee to a deposit account has been filed before the mailing of a Notice of Allowance, the issue fee will be automatically charged to the deposit account at the time of mailing the notice of allowance. 37 C.F.R. § 1.311(b).

NOTE: 37 C.F.R. § 1.28(b) requires "Notification of any change in loss of entitlement to small entity status must be filed in the application . . . prior to paying, or at the time of paying . . . issue fee." From the wording of 37 C.F.R. § 1.28(b): (a) notification of change of status must be made even if the fee is paid as "other than a small entity" and (b) no notification is required if the change is to another small entity.

☒ 37 C.F.R. § 1.492(e) and (f) (surcharge fees for filing the declaration and/or filing an English translation of an International Application later than 30 months after the priority date).

SIGNATURE OF PRACTITIONER

Clarence A. Green

(type or print name of practitioner)

PERMAN & GREEN, LLP

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Express Mail No.: EL627509059US
In re Application of: SCHIEFERDECKER et al.
INTERNATIONAL APPLICATION NO.: PCT/EP99/01170
INTERNATIONAL FILING DATE: 2/23/99
U.S. SERIAL NUMBER:
TITLE: SENSOR MODULE WITH INTEGRATED SIGNAL PROCESSING
ATTORNEY DOCKET NO.: 454-010513-US(PAR)

Box PCT
The Commissioner of Patents and Trademarks
Washington, D.C. 20231

PRELIMINARY AMENDMENT

Dear Sir:

Please amend the above-identified, patent application as follows:

IN THE SPECIFICATION:

After the Title and before the first paragraph, please insert the following new paragraph:

This application claims the benefit of the earlier filed International Application No. PCT/EP99/01170, International Filing Date, 23 February 1999, which designated the United States of America, and which international application was published under PCT Article 21(2) in German as WO Publication No.WO 00/50862.

IN THE CLAIMS

Please amend Claims 3 through and including 17 as rewritten below:

3. Sensor module according to claim 1, characterised in that the housing (22, 62, 64) has a cylindrical shape and the cylinder has a diameter of less than 10 mm.

4. Sensor module according to claim 1, characterised in that the housing (22, 62, 64) is a housing of the design TO5.

5. Sensor module according to claim 1, characterised in that the sensor signal processing circuit (13, 41a, 44a) is provided with a first amplifier (41a).

6. Sensor module according to claim 1, characterised in that the reference means (14, 15, 41b 43, 44b) comprises a reference element (14) and a second amplifier (41b).

7. Sensor module according to claim 1, characterised in that the reference means (14, 15, 41b 43, 44b) comprises one or several squaring means (43).

8. Sensor module according to claim 1, characterised by a compensation means (44a) for compensating the influence of the power dissipation of electronic components on the output signal.

9. Sensor module according to claim 1, characterised by a radiation-transmissible window (64, 66) provided in the housing (22, 62, 63), said window (64, 66) being electrically conductive or semi-conductive or having an electrically conductive or semi-conductive coating.

10. Sensor module according to claim 1, characterised by an optical imaging element (65, 66) provided in the housing (22, 62, 64).

11. Sensor module according to claim 9, characterised in that the imaging element (65, 66) forms the window (63, 66) of the housing (22, 62, 64).

12. Sensor module according to claim 10, characterised in that the imaging element (65, 66) comprises a lens (66) or a mirror (65).

13. Sensor module according to claim 1, characterised by preferably digital programming means (48, 51) provided in the housing (22, 62, 64) for setting the operating parameters of the sensor module.

14. Sensor module according to claim 1, characterised in that the combining means (16) is an analogous integrator amplifier.

15. Sensor module according to claim 1, characterised in that the combining means is a digital circuit (51) receiving the signals from the sensor means (13, 41a) and the reference means (14, 15, 41b) via A/D converters and outputting a digital, preferably temporally serial signal.

16. Sensor module according to claim 1, characterised in that the combining means is a digital circuit (51) outputting digital signal as YES/NO values to be used for monitoring a temperature threshold and/or for controlling one or more temperatures to one or more target values, the target values being programmable.

17. Sensor module according to claim 1, characterised in that the sensor signal processing circuit (13, 41a, 44a), the reference means (14, 15, 41b, 43, 44b) and the combining means (16, 51) are formed as an integrated circuit on one chip.

REMARKS

In accordance with 37 C F R. §1 121 (as amended on 11/7/2000) the rewritten claim(s) above are shown on separate page(s) marked up to show all the changes relative to the previous version of that section.

Respectfully submitted,

22 Aug 01

Clarence A. Green Reg. No.: 24,622
PERMAN & GREEN, LLP
425 Post Road, Fairfield, CT 06430
(203) 259-1800
Customer No.: 2512

Date

Application entitled: SENSOR MODULE WITH INTEGRATED SIGNAL PROCESSING

MARKED UP CLAIMS.

3. Sensor module according to claim 1 ~~or 2~~, characterised in that the housing (22, 62, 64) has a cylindrical shape and the cylinder has a diameter of less than 10 mm.

5. Sensor module according to ~~one of the preceding~~ claims 1, characterised in that
the housing (22, 62, 64) is a housing of the design TO5.

5. Sensor module according to ~~one of the preceding~~ claims 1, characterised in that the sensor signal processing circuit (13, 41a, 44a) is provided with a first amplifier (41a)

6. Sensor module according to ~~one of the preceding~~ claims 1, characterised in that the reference means (14, 15, 41b 43, 44b) comprises a reference element (14) and a second amplifier (41b).

7. Sensor module according to ~~one of the preceding~~ claims 1, characterised in that the reference means (14, 15, 4lb 43, 44b) comprises one or several squaring means (43)

8. Sensor module according to ~~one of the preceding~~ claims 1, characterised by a compensation means (44a) for compensating the influence of the power dissipation of electronic components on the output signal.

9. Sensor module according to ~~one of the preceding~~ claims 1, characterised by a radiation-transmissible window (64, 66) provided in the housing (22, 62,

63), said window (64, 66) being electrically conductive or semi-conductive or having an electrically conductive or semi-conductive coating.

10. Sensor module according to ~~one of the preceding~~ claims 1, characterised by an optical imaging element (65, 66) provided in the housing (22, 62, 64).

11. Sensor module according to claim 9 ~~and 10~~, characterised in that the imaging element (65, 66) forms the window (63, 66) of the housing (22, 62, 64).

12. Sensor module according to claim 10 ~~or 11~~, characterised in that the imaging element (65, 66) comprises a lens (66) or a mirror (65).

13. Sensor module according to ~~one of the preceding~~ claims 1, characterised by preferably digital programming means (48, 51) provided in the housing (22, 62, 64) for setting the operating parameters of the sensor module.

14. Sensor module according to ~~one of the preceding~~ claims 1, characterised in that the combining means (16) is an analogous integrator amplifier.

15. Sensor module according to ~~one of the~~ claims 1 ~~to 13~~, characterised in that the combining means is a digital circuit (51) receiving the signals from the sensor means (13, 41a) and the reference means (14, 15, 41b) via A/D converters and outputting a digital, preferably temporally serial signal.

16. Sensor module according to ~~one of the~~ claims 1 ~~to 13 and 15~~, characterised in that the combining means is a digital circuit (51) outputting digital signal as YES/NO values to be used for monitoring a temperature threshold and/or for controlling one or more temperatures to one or more target values, the target values being programmable.

18. Sensor module according to ~~one of the preceding~~ claims 1, characterised in that the sensor signal processing circuit (13, 41a, 44a), the reference means (14, 15, 41b, 43, 44b) and the combining means (16, 51) are formed as an integrated circuit on one chip.

Als vom Präsidenten des Landgerichts München II öffentlich bestellte und allgemein beeidigte Dolmetscherin und Übersetzerin für die englische Sprache bestätige ich: Vorstehende Übersetzung der mir in Kopie vorgelegten, in deutscher Sprache abgefaßten internationalen Patentanmeldung mit dem Aktenzeichen PCT/EP 99/ 01170 vom 23. Februar 1999 ist richtig und vollständig.

As interpreter and translator for the English language publicly appointed and generally sworn by the President of the Regional Court Munich II I certify: The above translation of the international patent application with the reference number PCT / EP 99 / 01170 of February 23, 1999, formulated in German and presented to me in copy is correct and complete.

Wimpasing, 08.08.01

Tina Langhaeuser
Am Wallgraben 19 a
82541 Ammerland/
Wimpasing

Tina Langhaeuser,
öffentlich bestellte und beeidigte
Dolmetscherin und Übersetzerin
für die englische Sprache

09/914083
518 Rec'd PCT/PTO 22 AUG 2001

8/prts

SENSOR MODULE WITH INTEGRATED SIGNAL PROCESSING

The present invention relates to a sensor module according to the preamble of claim 1. Such a sensor module is known from the DE 43 31 574 A1. The invention relates to an infrared sensor module particularly applicable to cooking, baking and heating apparatuses, for example in microwave ovens.

Figure 1 is a schematic block diagram as described in the above state of the art. 12 denotes the actual sensor element which is radiation-sensitive and outputs an electric signal to its clamps when electromagnetic radiation is incident. It may, for example, be a thermocouple. An amplifier 13 amplifies the electric signal of the sensor element. For balancing physically induced influences of the ambient temperature on the output signal of the sensor element, a reference means (14, 15) is further provided which is also temperature-sensitive. 14 denotes a temperature reference sensor, preferably a thermal resistor provided near the sensor and changing its parameters in accordance with its temperature. 15 denotes an amplifier or impedance converter converting said change into a usable electric signal which, combined with the amplified signal of the sensor element, reduces the influence of the ambient temperature on the signal from the radiation sensor. 16 denotes a differential amplifier obtaining the difference between the signals from the radiation sensor (12, 13) and the temperature sensor (14,15) and outputting an approximately ambient temperature-compensated and object temperature-dependent output signal 11.

The known circuit has various disadvantages: The temperature compensation acts optimally only for a relatively small ambient temperature range since the characteristics of known miniaturised temperature reference elements are typically linear or exponential while a dependence with about the 4^{th} power has proved particularly favourable. The signal amplification and processing are provided on a circuit board outside of the transistor housing in which the sensor chip and the temperature reference sensor are disposed. Since the sensor module is comparably large, space problems may occur in the integration in appliances. Above that the construction with the signal processing outside the metallic sensor housing may also lead to a falsification of the signal by electromagnetic interferences. This influence needs to be eliminated by expensive and complicated shielding measures or a subsequent signal processing.

It is the object of the invention to provide a sensor module capable of outputting an accurately temperature-compensated output signal corresponding to the temperature of an object. Said object is solved by the features of claim 1. The dependent claims are directed to preferred embodiments of the invention.

A sensor according to the invention comprises a radiation-sensitive sensor element, a sensor signal processing circuit, temperature-sensitive reference means, a signal combining means and, if required, different means for parameter adjustment and calibration. The sensor signal processing circuit, the reference means and the signal combining means are formed on a single chip (an application specific integrated circuit). The chip for the sensor signal processing and the sensor element are accommodated in a common housing. In addition, the sensor element may be disposed on a single chip together with the sensor signal processing circuit, the reference means and the signal combining means.

The housing is preferably relatively small. It may, for example, be a commercially available TO5 or TO18 housing. In a certain cutting plane it may be formed so that no dimension of the cross section is larger than 12 mm. It may be a cylindrical housing the diameter of the cylinder being no larger than 9 mm.

The reference means serves to compensate the temperature path of the sensor element. Since the temperature path of the sensor element is generally non-linear, its temperature path can only unsatisfactory be simulated by a linear reference means. It has been found that an exponential function is suitable for simulating the temperature path of the sensor element over narrow ranges and that a power function is suitable for simulating the temperature path of the sensor element over wide ranges. In particular a square or power function of higher order may be used to evaluate the signal generated depending on the radiation sensor and to optimally simulate the temperature path of the sensor element. A 4^{th} order power function has been proved to be the preferable function for an optimum compensation of the temperature path of the sensor element.

The signal combining means may be provided with an adder or subtractor, particularly a integrator amplifier or a differential amplifier. The selection of one of said means is effected depending on a qualitative comparison of the temperature path of the sensor element on the one hand and the temperature path of the reference means on the other as well as further depending on possibly effected sign evaluations. If the temperature path of the reference means and the sensor element itself are, for example, parallel (if, for example, both output signals drop with the temperature increasing), a differential amplifier may be used, when no further sign evaluation of the signals is effected. If one of the signals, for example the one from the reference means, is negatively validated (for example, by the impedance converter), a integrator amplifier may be used.

The signal of the sensor element is not only influenced by the ambient temperature but also by the allowances and the power dissipation of the circuit. Therefore a compensation means for compensating the power dissipation of the ASICs as well as calibration means for reducing the influence of allowances and offsets may be provided.

For setting or adjusting the sensor for different conditions a preferably digital programming means may also be provided in the housing by which the analogous or digital parameters of the sensor can be adjusted or changed.

Individual embodiments of the invention will be described below with reference to the drawings in which:

Fig. 1	shows a known circuit;
Figs. 2a - f	show embodiments of the invention;
Fig. 3	is a cross sectional view of a sensor according to the invention including an optical imaging means;
Fig. 4	shows a circuit design according to the invention;
Fig. 5	shows another circuit design according to the invention;
Fig. 6a - c	are further cross sectional views of a sensor according to the invention including an optical imaging device;
Fig. 7	shows another embodiment of the invention; and
Fig. 8a, b	are illustrations of the typical housing layouts TO5 (Figure 8a) and TO18 (Figure 8b).

Figures 2a - f are schematic top views of the designs of sensors according to the invention. In the illustrations the same numerals as used in Fig. 1 specify identical components. 20 denotes an integrated circuit comprising at least the components 13 to 16 of Fig. 1. It may be an ASIC. Separate from the integrated circuit 20 the sensor element 12 is provided which may be connected to the integrated circuit 20 via bonding connections. Via further bonding connections the integrated circuit 20 is connected to the external terminals 11.

The construction according to Figures 2a - c is hybrid in so far as the sensor element 12 is provided independent of the integrated circuit 20. Different possible connections are illustrated. Figures 2d - f show designs in which the sensor element is provided on the integrated circuit 21 itself. In this case also the connection to the terminals 11 is effected via bonding connections. Different possible connections are shown which will be described later.

22 denotes a schematic illustration of the bottom plate of a cylindrical housing having a diameter of maximally 10 mm. In this housing the integrated circuit 20 (the sensor signal processing circuit, the reference means, the signal combining means) as well as the sensor element 12 itself are accommodated in a hybrid construction or together on one chip 21.

Fig. 3 shows a cross section of a sensor according to the invention having a hybrid construction. The sensor is designed to detect electromagnetic radiation, particularly infrared radiation, from an object 30. It is provided with an optical imaging or collecting element 31 attached on the outside which forms an image of the radiation emitted by the object 30 on the sensor element 12 inside the sensor or collects it there.

The housing 22 is preferably closed on all sides. It is provided with a window 32 for the passage of the radiation, said window being transmissible for at least the relevant wave length range of the electromagnetic radiation. It may further be at least partly intransmissible, in which case it fulfils the function of a filter. The housing may otherwise be formed so as to be radiation-shielding, for example by forming the walls and bottom of an electrically conductive material and by making the window partly electrically conductive or semi-conductive.

Fig. 4 is a block diagram of an embodiment of a circuit 20 according to the invention. 20 denotes the ASIC shown in Fig. 2a. The illustrated components are thus provided as an integrated circuit on a chip. 40 denotes the terminals through which the signal of the sensor element is received. 41a denotes a preamplifier or only an impedance converter preferably provided with calibration means. 44a denotes an offset correction. Parallel to the described branch another branch extends. It is provided with a entry side reference element 14. The reference element is thermally coupled to the sensor and supplies a signal corresponding to the temperature of the sensor, preferably in linear dependence. 41b denotes another preamplifier or impedance converter.

43 denotes elements for the characteristics simulation. They simulate as accurately as possible the temperature characteristic of the sensor element on the clamps 40 in a certain temperature range. It has been found that the temperature path of the sensor element 12 is non-linear (at the clamp 40). In so far the temperature path can only partly be simulated accurately by a linear temperature sensor element 14. The Simulation 43 may therefore be an exponential function for narrow temperature ranges or a power function. Second or fourth order power functions are preferable. The square function is generated from a signal from the temperature reference element by a squaring circuit 43, said signal being linearly dependent on the temperature. The series connection of two squaring units 43 results in a 4^{th} order power function. 44b denotes an additive offset correction. 46a and 46b denote change-over switches the purpose of which will be described later. 16 denotes the combining means. It may be formed as a integrator amplifier in which the degree of amplification can be programmed. It may be an embodiment in which the temperature path of the temperature sensor element 14 is opposed to the one of the actual sensor element 12 or in which the temperature paths are identical but a sign change is effected, for example, in the reference branch.

41c may be a filter circuit or a sample-and-hold circuit to generate a band-limited or temporally continuous output signal which may be coupled out with low impedance. At the output 11c, finally, the signal corresponding to the electromagnetic radiation to be detected may be received in a temperature compensated state.

The change-over switch 46b may be used to select whether the sensor signal is to be output in a temperature compensated state (upper switch position) or in a non-compensated state (lower switch position). In the latter case, preferably, a reference voltage source 47 is connected with the input of the integrator amplifier otherwise occupied by the temperature reverence voltage to keep the integrator amplifier on a defined potential. With the change-over switch 46a a temperature signal (upper switch position) or a reference voltage signal (lower switch position) may be

selectively applied to another filter switch or sample-and-hold switch 41d so that the corresponding signals may be tapped at the output 11d.

A compensation means may be provided to compensate the influence of the power dissipation of the described electronic components. The power dissipation results in a heating of the electronic components influencing the output signal of the sensor element. With the mentioned compensation means this can be prevented. Since the power dissipation of the electronic circuit on the chip can be approximated to a constant value it may be compensated by an appropriate adjustment of the offset compensation 44a.

In another embodiment a preferably digital programming means 48 may be provided. It is accessible from the outside via the terminals 11b and may serve to set system parameters. With the programming means 48 amplification factors of the amplifiers 41a, 41b, 16, offset voltages of the components 44a, 44b, switch positions of the switches 46a, 46b, the reference voltage 47, parameters of the simulations 43, filter coefficients of the circuits 41c, 41d and the like may be set. They may be set in a fixed way (for example by integrated securing means) or in a variable way (for example by means of rewritable memories) and are in both cases programmable by access via external terminals.

The programming means 48 may also be designed for the purpose of setting or changing the allocation of electric terminals 11, 11a - d to electronic components of the sensor. In this way external terminals 11 may be saved. The programming means 48 may have a single terminal or two terminals which may be provided in addition to the other (preferably analogous) terminals. It may receive temporally serial signals. The terminals may also be used bidirectionally. The circuit is preferably provided with three to six terminals 11. Figures 2a and 2d show embodiments with three terminals which may, for example, be supply voltage, mass and output signal terminal. In such an embodiment the terminals may also be variably occupied. Switching may, for example, be effected by means of the supply voltage modulated with a change signal. Figs. 2b and 2e show embodiments with four ter-

minals, for example, mass, supply voltage, output signal and analogous or digital control input. Figs. 2c and 2f show embodiments provided with six terminals (for example mass, supply voltage, compensated output signal, control input, linear temperature output, threshold monitoring output).

The amplification of the amplifiers 41a and 16 may be set so that characteristic value tolerances of the sensor element 12 and the sensor signal processing are balanced by the amplification of the amplifier 41a while the sensor output signal can be adjusted to the desired value range by the amplification of the amplifier 16.

The output voltages of the sensor may, for example, be set in a range from 0 to 5 V or in a range from 0 to 3 V. The temperature compensation is preferably selected so that an optimum sensor signal compensation is obtained in an ambient temperature range from -20°C to 100°C. The terminals 11a preferably serve the voltage supply of the sensor module.

Fig. 5 shows another embodiment of the invention in which a mainly digital signal processing is performed. Like in Fig. 4, 40 denotes the terminals for the sensor element 12. 11a denotes the voltage supply terminals. An yet analogous signal from the preamplifier or impedance converter 41a preferably comprising a calibration means arrives at a digital circuit 51 (a micro controller). It comprises input side A/D converters 52 to 54 receiving analogous signals from the input amplifier 41a, from the temperature reference element 14 and from the constant voltage source 47. The other components of Fig. 4 are replaced by digital devices.

The characteristics simulation 43 may be replaced by a formula or a table allocating specific output values to the input values. The output signals may also be output digitally via one or more terminals 11e. Then, for example, the uncompensated radiation sensor signal, the temperature signal, the compensated radiation sensor signal and the reference voltage signal may be successively transmitted. Depending on the kind of application of the sensor a threshold inquiry may also be implemented which results in a YES/NO signal a being output for a threshold value

to be monitored. If a plurality of threshold values are monitored, correspondingly a plurality of such signals may be output in parallel or successively.

The voltage reference 47 may, for example, be formed as a band gap voltage reference circuit or it may comprise a Zener diode. The temperature reference element 14 may be formed as a PTAT sensor.

Further embodiments of the invention are shown in Figs. 6a - c. They are schematic cross sectional views of a housing of the design TO5 or a smaller housing, for example a TO18. It has a cylindrical shape and comprises a bottom plate 62 through which the terminals 11 are lead to the outside. On the bottom plate 62 the actual sensor element 12 as well as the integrated circuit 20 are disposed. The housing is sealed. The sealing 64, 62 may be composed of a metallic material to shield off electromagnetic disturbances. In the housing wall a window 63 is provided which is transmissible for at least the relevant wave length range of the electromagnetic radiation. Above that the window 63 may be conductive or semi-conductive or have a conductive or semi-conductive coating to shield off electromagnetic radiation. The window 63 is preferably provided in the upper face of a cylindrical housing. Inside the housing an imaging or beam guide means 65 is provided. In the illustrated embodiment it is, for example, a rotationally symmetric parabolic mirror guiding light incident in the housing through the window to the sensor element 12.

Instead of a mirror guide a lens 66 may be provided which focuses incident light onto the sensor element (Figure 6b). The lens may be disposed inside the housing or outside of the sensor housing and may form a part of the housing wall sealing the sensor housing.

For avoiding signal falsification and image falsification due to reflections on the inner housing wall a shadowing means may be provided on the inner housing wall.

Figs. 6b and 6c show embodiments in which masks 67, 68 are provided adjacent to the lens in the housing, said masks being disposed in a partly staggered manner to suppress signal reflections inside of the housing as far as possible. The surfaces of the masks are preferably formed so as to absorb radiation. Furthermore, the masks 67, 68 have the function of reducing the interfering influence of sudden changes of the ambient temperature on the output signal of the radiation sensor. To this end the masks are preferably formed of a material having a bad thermal conductivity.

Fig. 7 shows an embodiment of the invention comprising a mounted circuit board and a plug for an electric coupling. It is a sensor module as described above, sealed in a cylindrical housing with a cap diameter of maximum 9 mm and mounted on a circuit board, which may be connected to at least three terminals via a plug.

Fig. 8 illustrates embodiments of the TO5 housing (Fig. 8a) and the TO18 housing (Fig. 8b). They are a substantially cylindrical housings, the cylindrical bodies of which have a diameter of about 8.2 mm (TO5) or 4.8 mm (TO18). The terminals 11 are disposed on one of the face sides and distributed over a circle concentric with respect to the cylinder and having a diameter of approximately 5.1 mm (TO5) or 2.5 mm (TO18). The sensor module of the invention may be accommodated in such a housing. It may also be accommodated in a housing having a smaller base than the described TO housings, in which, however, particularly the arrangement of the terminals 11 on the housing is effected in accordance with the TO standards.

The sensor module is particularly applicable to a contact-free temperature measurement. The sensor element 12 and the optical window 63 or the optical imaging means 66 may particularly be designed for the detection of infrared radiation or for letting infrared radiation pass. The infrared radiation is preferably detected by a thermopile sensor.

CLAIMS

1. Sensor module comprising

a radiation-sensitive sensor element (12) providing a radiation-dependent electric output signal,

a sensor signal processing circuit (13, 41a, 44a) receiving the output signal from the sensor element (12) and providing a radiation-dependent first electric signal,

a temperature-sensitive reference means (14, 15, 41b, 43, 44b) providing a temperature-dependent second electric signal, and

a combination means (16) for combining the two electric signals,

characterised in that

the sensor signal processing circuit (13, 41a, 44a), the reference means (14, 15, 41b, 43, 44b) and the signal combining means (16) are formed on a single chip (20, 21), and

the chip (20, 21) and the sensor element (12) are accommodated in a common housing (22, 62, 64).

2. Sensor module according to claim 1, characterised in that the housing (22, 62, 64) is provided with electrically conductive or semi-conductive walls.

3. Sensor module according to claim 1 or 2, characterised in that the housing (22, 62, 64) has a cylindrical shape and the cylinder has a diameter of less than 10 mm.

4. Sensor module according to one of the preceding claims, characterised in that the housing (22, 62, 64) is a housing of the design TO5.

5. Sensor module according to one of the preceding claims, characterised in that the sensor signal processing circuit (13, 41a, 44a) is provided with a first amplifier (41a).

6. Sensor module according to one of the preceding claims, characterised in that the reference means (14, 15, 41b 43, 44b) comprises a reference element (14) and a second amplifier (41b).

7. Sensor module according to one of the preceding claims, characterised in that the reference means (14, 15, 41b 43, 44b) comprises one or several squaring means (43).

8. Sensor module according to one of the preceding claims, characterised by a compensation means (44a) for compensating the influence of the power dissipation of electronic components on the output signal.

9. Sensor module according to one of the preceding claims, characterised by a radiation-transmissible window (64, 66) provided in the housing (22, 62, 63), said window (64, 66) being electrically conductive or semi-conductive or having an electrically conductive or semi-conductive coating.

10. Sensor module according to one of the preceding claims, characterised by an optical imaging element (65, 66) provided in the housing (22, 62, 64).

11. Sensor module according to claim 9 and 10, characterised in that the imaging element (65, 66) forms the window (63, 66) of the housing (22, 62, 64).

12. Sensor module according to claim 10 or 11, characterised in that the imaging element (65, 66) comprises a lens (66) or a mirror (65).

13. Sensor module according to one of the preceding claims, characterised by preferably digital programming means (48, 51) provided in the housing (22, 62, 64) for setting the operating parameters of the sensor module.

14. Sensor module according to one of the preceding claims, characterised in that the combining means (16) is an analogous integrator amplifier.

15. Sensor module according to one of the claims 1 to 13, characterised in that the combining means is a digital circuit (51) receiving the signals from the sensor means (13, 41a) and the reference means (14, 15, 41b) via A/D converters and outputting a digital, preferably temporally serial signal.

16. Sensor module according to one of the claims 1 to 13 and 15, characterised in that the combining means is a digital circuit (51) outputting digital signal as YES/NO values to be used for monitoring a temperature threshold and/or for controlling one or more temperatures to one or more target values, the target values being programmable.

17. Sensor module according to one of the preceding claims, characterised in that the sensor signal processing circuit (13, 41a, 44a), the reference means (14, 15, 41b, 43, 44b) and the combining means (16, 51) are formed as an integrated circuit on one chip.

Figure 1

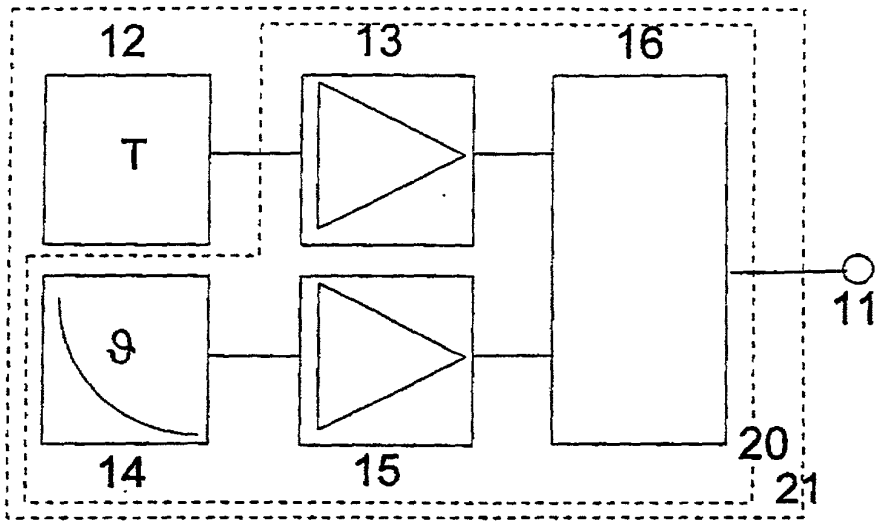


Figure 2

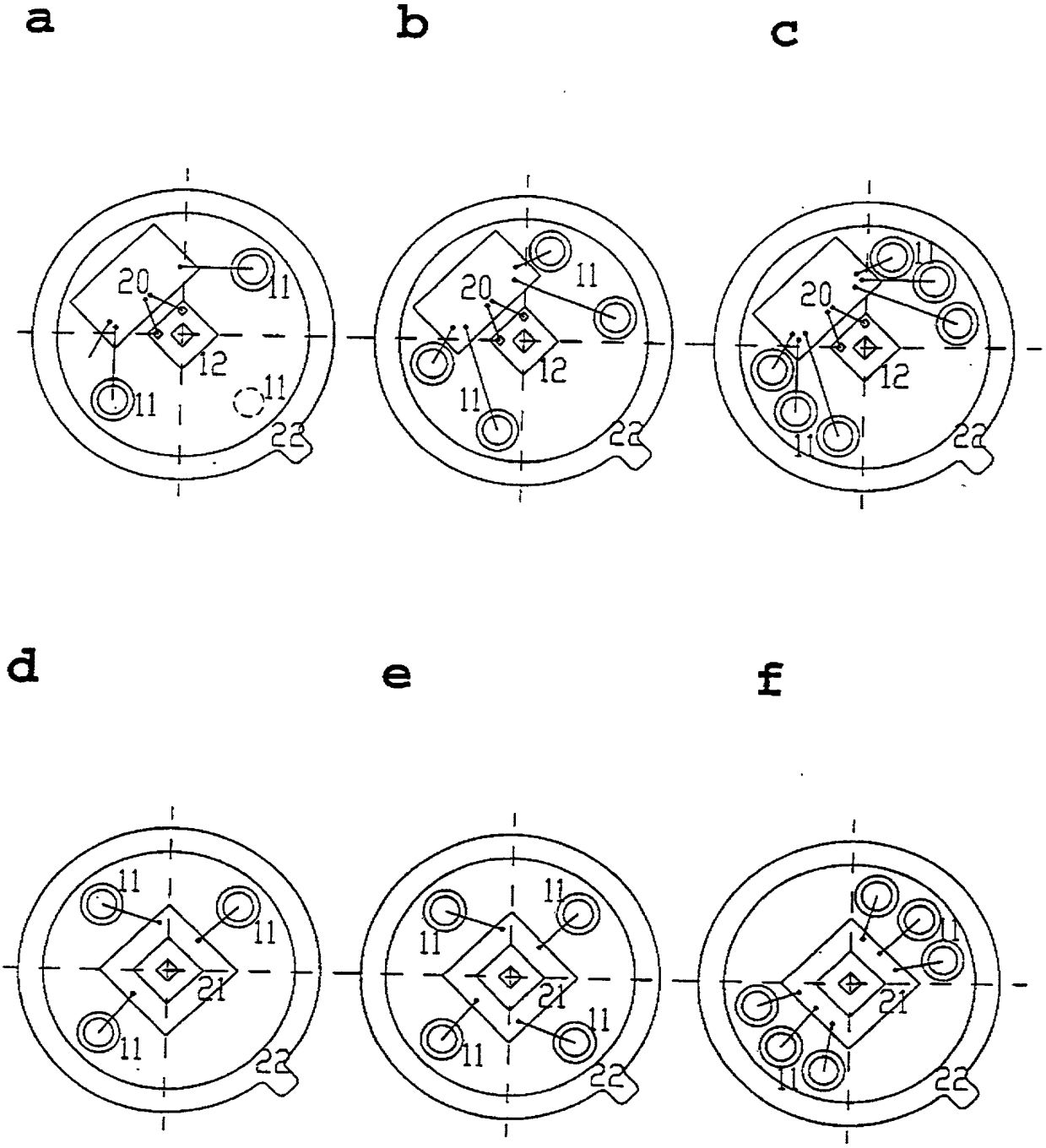


Figure 3

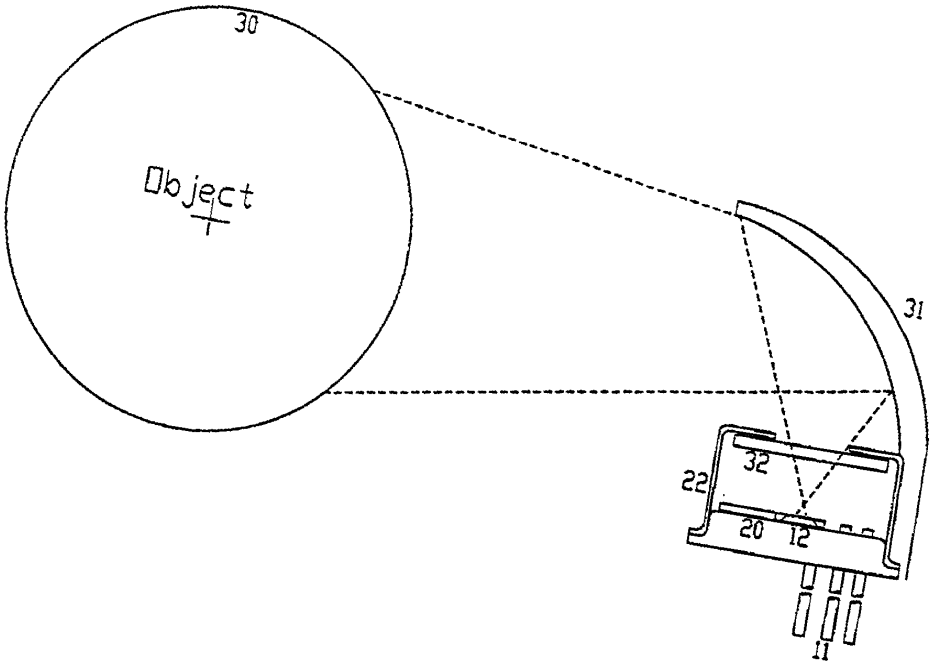


Figure 4

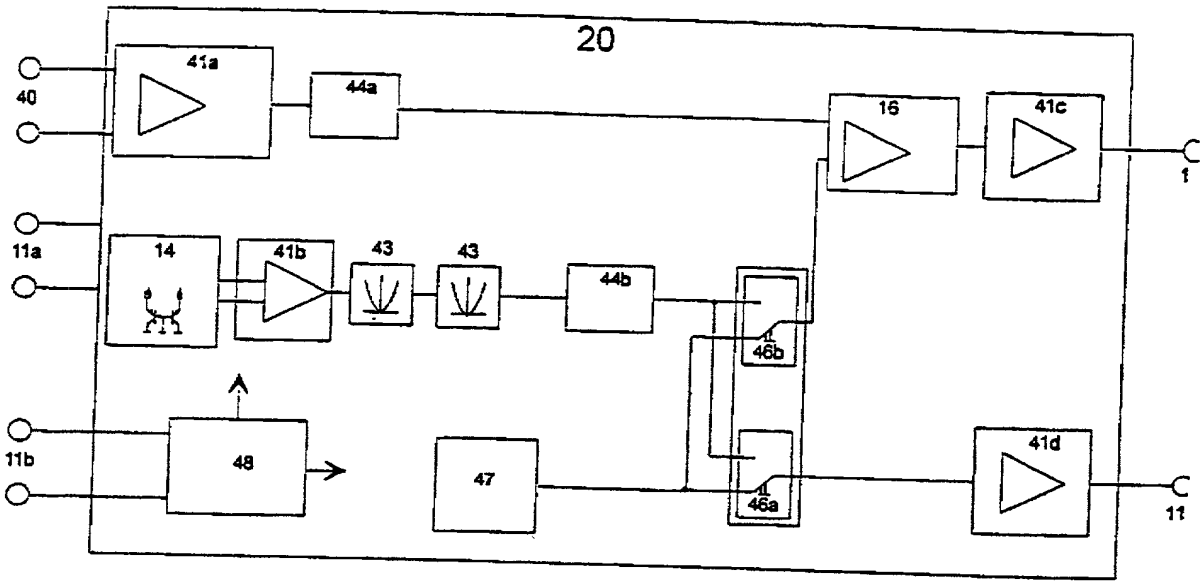


Figure 5

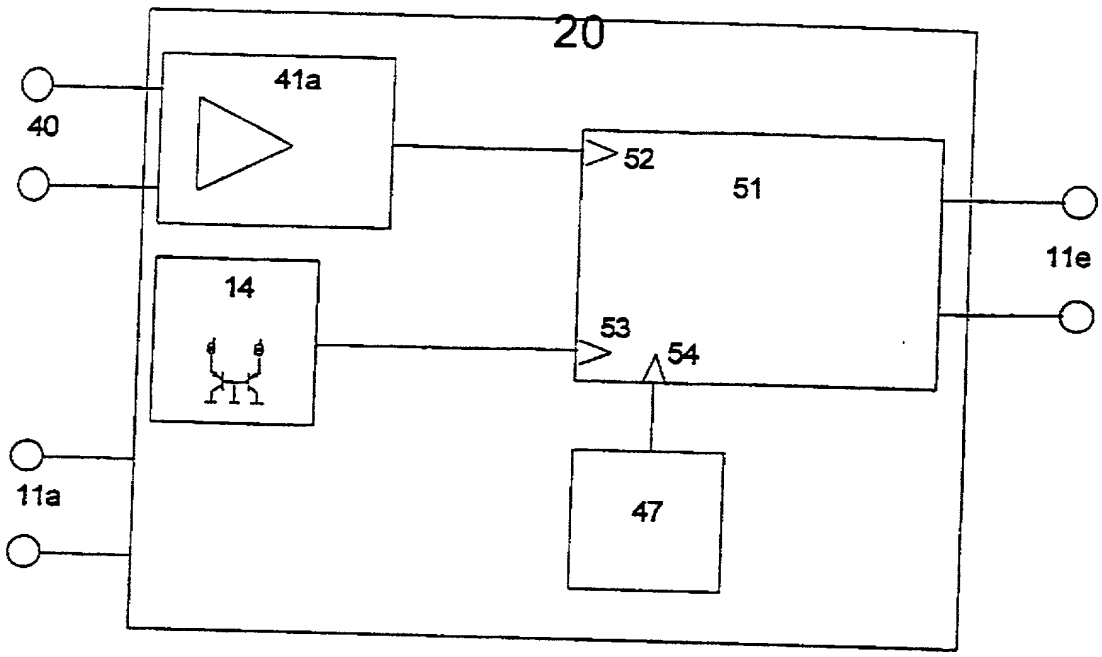


Figure 6a

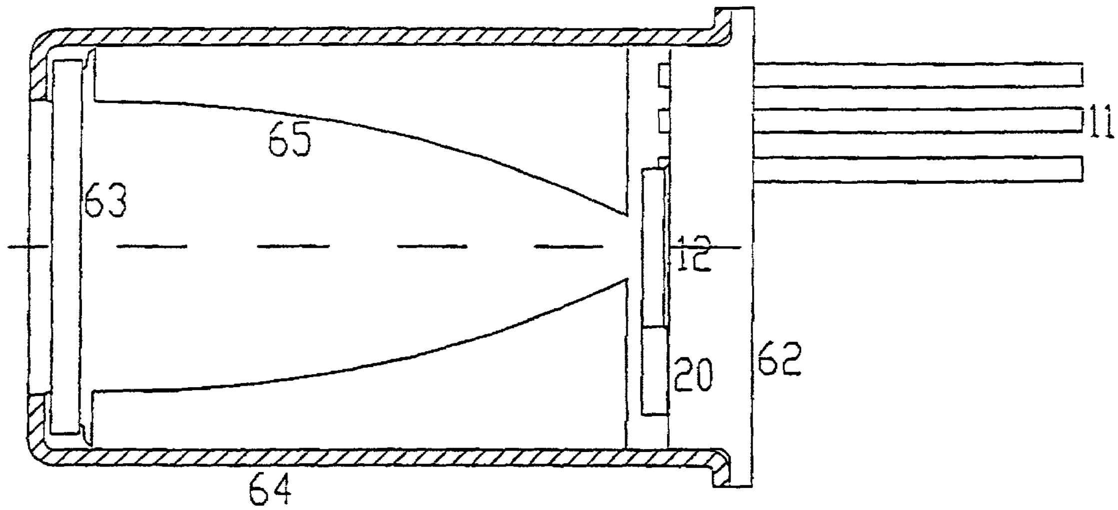


Figure 6b

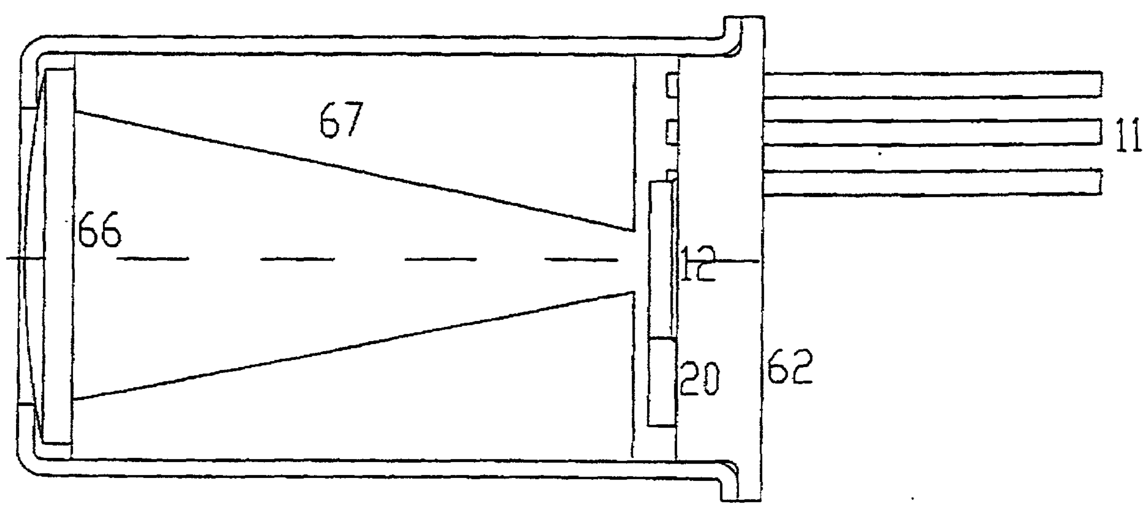


Figure 6c

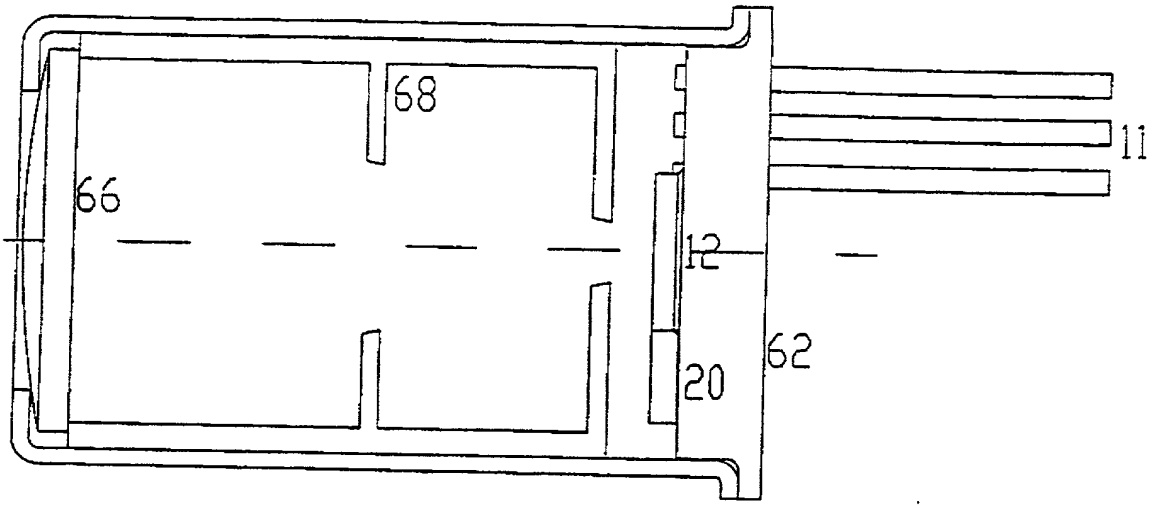


Figure 7

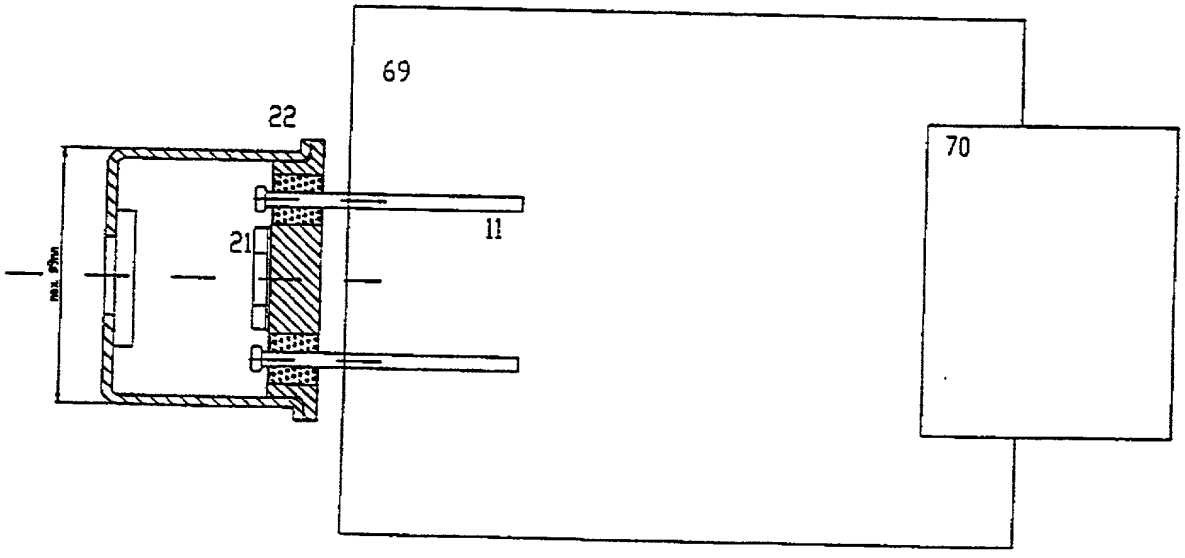


Figure 8a

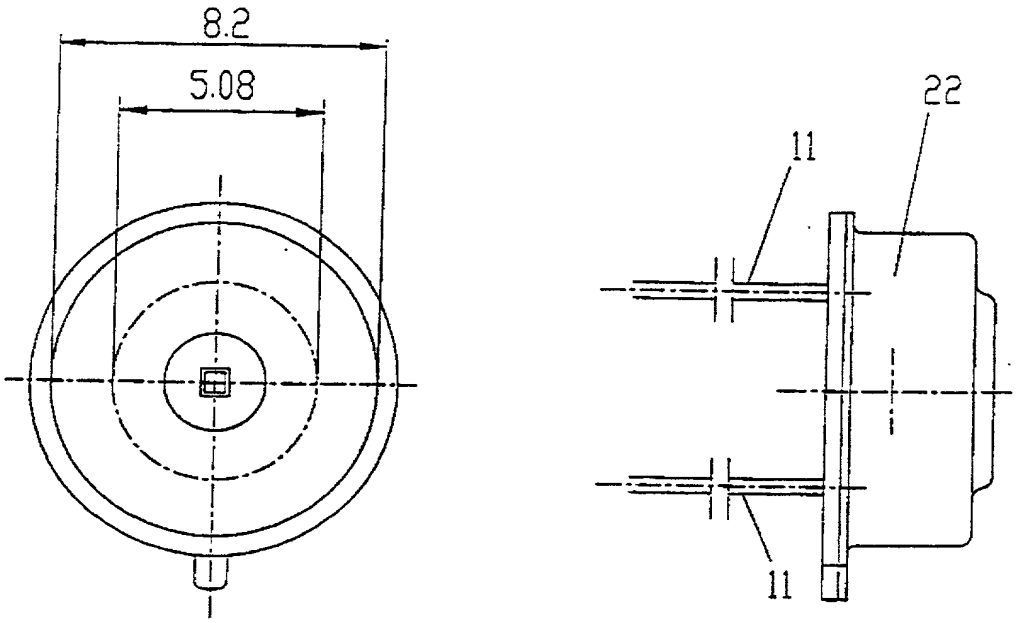
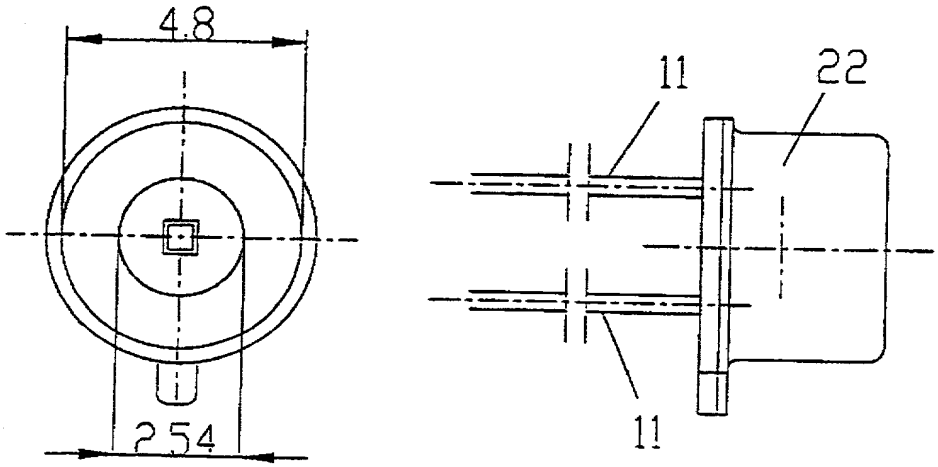


Figure 8b



Docket No.: 454-010513-US(PAR)

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

English Language Declaration

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Title: SENSOR MODULE WITH INTEGRATED SIGNAL PROCESSING

the specification of which

(check one)

☐ is attached hereto.

X was filed on as United States Application No. **09/914,083** or PCT International Application Number **PCT/EP99/01170 filed February 23, 1999**

and was amended on (if applicable) _____

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d) or Section 365(b) of any foreign application(s) for patent or inventor's certificate, or Section 365(a) of any PCT International Application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)

(Number)	(Country)	(Day/Month/Year Filed)	Priority Not Claimed
PCT/EP99/01170	PCT	23 February 1999	☐
			☐
			☐
			☐

I hereby claim the benefit under 35 U.S.C. Section 119(e) of any United States provisional application(s) listed below:

_____ _____
(Application Serial No.) (Filing Date)

_____ _____
(Application Serial No.) (Filing Date)

_____ _____
(Application Serial No.: (Filing Date)

I hereby claim the benefit under 35 U.S.C. Section 120 of any United States application(s), or Section 365(c) of any PCT International Application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International Application in the manner provided by the first paragraph of 35 U.S.C. Section 112, I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, C.F.R., Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

_____ (Application Serial No.)	_____ (Filing Date)	_____	(Status) (patented, pending, abandoned)
_____ (Application Serial No.)	(Filing Date)	_____	(Status) (patented, pending, abandoned)
_____ (Application Serial No.)	_____ (Filing Date)	_____	(Status) (patented, pending, abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number)

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Third Inventor's signature: DATE

Residence address:

Citizenship:

Post Office Address:

Full name of fourth inventor:

Fourth inventor's signature: DATE

Residence address:

Citizenship:

Post Office Address:

Full name of fifth inventor:

Fifth inventor's signature: DATE

Residence address:

Citizenship:

Post Office Address:

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